PRESENT STATUS OF THE TANK ARMOR PROGRAM AND PROPOSED PROGRAM FOR DEVELOPMENT OF ARMOR TO DEFEAT HEAT AND HEP PROJECTILES

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ABSTRACT

This Technical Note presents the present status of the tank armor program, the proposed program for the immediate future, and an outline of the long range program. A review of the program proposed in August 1950 is made and proposals to meet the increase in scope and urgency demanded of this program are presented.

INTRODUCTION

The urgent need for answers to a large number of questions about tank armor has increased the rate of work on these problems and the number of people interested. This increased interest makes it desirable to have an interim report at this time so that all those concerned may know the present status and the plans for future work. Both the immediate plans and the long range program should be included.

The BRL were assigned the responsibility for the study of specialized armor for the defense against shaped charges and HEP head projectiles. In August 1950 the BRL, in BRL Technical Note No. 281, proposed the following general plan.

"1. that a contract be placed with a glass fabricator to develop a glass armor suitable for application to steel that would give protection from 3.5 in. rocket and 90mm T108 projectiles." Tests by Dr. Pugh at Carnegie Institute of Technology have shown that glass blocks or plates have shown unusual properties in defense against shaped charges. These properties should be investigated more thoroughly.

"2. that spike designs capable of defeating the 3.5 in. rocket and the 90mm T108 be developed and tested by Aberdeen Proving Ground." The purpose of the spikes is to disrupt the cone before completion of the detonation.

"3. that tests and design studies be carried out to determine practicable method of using plastic explosives as a method of defense against the hollow charge." It appears that thin plates of explosive placed on the armor will detonate, disrupt the jet and prevent penetration.

"4. that each practicable armor type successful in defeating the hollow charge projectile be tested for its resistance to attack by the 105mm T81 projectile."

These proposals basically remain much the same today. However, some detailed changes and additions have been made. The status of the program up to date follows:

In connection with the first proposal, two contracts have been proposed, one with Kalo Engineering Company of Oldsmar, Florida, the other with the Flintkote Company, Whippany, New Jersey. The study of glass will be included in one or both of these contracts, but the study will extend beyond this. The Kalo Engineering Company will make a special effort to produce a plastic (or find a material that is embedded in a plastic) that will defeat the shaped charge. The Flintkote Company

will direct their study to embedded materials with special reference to a practicable use of the properties of glass. The matrix (at least for the first of the study) will be a bituminous material, such as used in HCR2 which they produced during the last war. Both of these companies will study the reports of past tests and will be aware of the work being done by the other.

Any material that shows promise of unusual protection against shaped charges will be tested further against AP Projectiles. HEP will then be tried on any material or arrangements of materials that appear superior to ferrous armor in its overall ability to defeat both hollow charge and AP projectiles.

In connection with the second proposal in 281, the design and pattern of spiked armor chosen for the first tests at Aberdeen Proving Ground were based on the studies made under the direction of NDRC during World War II. This particular design and pattern had not been tried but represented the choice of those working on the problem at the time as the next to be tested. The most serious problem turned out to be the fabricating of plates for tests. Machining, welding, and casting of spikes were considered. Each presented problems that seemed more difficult than the previous one - depending entirely upon how far the details were pursued.

Machining would be very simple for a test plate requiring only a few spikes, but the drilling and tapping of six thousand one inch holes in two inch steel presents a job of tremendous proportions for the already overloaded Proving Ground facilities, and would not represent armor that could be used on tanks.

Welding around the base of the spike on a test plate would be an "almost impossible" job and probably would be impossible for mounting them on a tank. The strength of the weld and the effect of the weld on the plate would be problems even if a method could be found to reach between spikes to do the welding. A proposal to drill holes, insert the spike and weld the base involves almost as much work as machining and has many of the uncertainties of welding.

Casting might be possible, but several large founderies either refused the job or foresaw very serious problems. A problem of heat-treating the spikes after casting would remain even if the castings could be obtained.

There appears to be a relatively simple method of mounting spikes by stud welding but even this method leaves many problems. A contract

is being negotiated with the Nelson Stud Welding Company, Lorain, Ohio, to study these problems and develop a simple method of attaching spikes to steel and armor. It is proposed that they provide plates for tests at APG.

The use of plastic explosives mentioned in the third proposal presents a hazard as well as a problem. It is still proposed to initiate tests to determine the best explosive, the best proportions, and the best arrangement of the explosive to defeat the 3.5 in. rocket. Any armor that would defeat the shaped charge would still have to be tried by the other type projectiles. These studies will proceed as soon as other tank armor problems are under way and the necessary personnel is available.

The fourth proposal refers to tests other than shaped charges. Any armor suitable for a tank must be able to defeat any type of projectiles which may be used against it. An armor developed to defeat hollow charges must be tested by AP and HEP projectiles before it can be considered acceptable for tank use. One particular projectile that will be used is the 105mm T81.

FURTHER PROPOSALS

These has been an increase in the urgency and in the number of problems. BRL has assigned additional personnel to these tests and the following five points are also included in the present proposals.

1. The known facts and theories concerning the penetration of shaped charges are not perfected to such a point that the best armor can be predicted. Therefore it will be necessary to perform tests of many materials in an effort to determine one that will possess the necessary properties for a good armor. Small shaped charges have been ordered to use in these tests and several materials are on hand to test as soon as the charges become available. Other materials will be procured and tested later. Those on hand now are

   a. Mycalex by the Mycalex Corporation of America Clifton, New Jersey
   b. Kaylo Plastic - Types I & II by Kalo Engineering Company, Oldsmar, Florida
   c. Transite by Johns Marville Company
   d. Vermiculite by International Vermiculite Company, Gerard, Illinois
   e. Natural Materials (Sand, Gravel, Crushed Rock)

Tests of sand, gravel, and crushed rock are in progress. The 2.36 inch rocket is being used rather than wait for the special

charges. These materials are being considered, because the might yield a simple field solution for the problem were the present tanks to encounter this type of attack. A study is being conducted to determine if there are significant differences in the protection offered by coarse, medium, and fine sand; also to see if there is a difference between dry, damp, and flooded materials. Crushed rock will be tested to compare to sand and gravel.

Physical and chemical analysis will be made of the materials tested.

2. Spaced armor will be tested. There is no question in the minds of many that spaced armor has some advantage, but the design of a spaced armor that can be used on a tank is not simple. First, the amount of space required may be far too much to permit use on tanks. Second, fabrication of spaced armor may be a problem even if space requirements are not excessive. A study will be made to determine the effectiveness of different types of spacing against existing shaped charge projectiles.

3. Closely related to spaced armor is the "sandwich" armor: that is, armor consisting of layers of steel and non-ferrous materials. If tests of this type of material or arrangements of materials are made, it will be after the testing of spaced armor and the testing of the materials themselves.

4. Heavy Aluminum Armor is being procured for tests. Cast aluminum is on hand and will be tested first. Special plates of tempered aluminum armor will be tested later. The plates are to be 5.6 inches thick and backed by 2 inches of steel armor. They are to be tested with AP projectiles and 3.5 inch rockets to determine the vulnerability of full scale armor.

5. Partial as well as complete protection will be considered in all cases. The weapons now available make complete protection extremely difficult, but if the use of tanks continues research will also continue for the best possible protection against known weapons.

CONCLUSION

Studies of both active and passive armors will continue at an increased rate. Partial protection as well as complete protection will be considered. Small shaped charges and full scale rounds will be used. Many types and arrangements of materials will be tested. Finally any materials or arrangements that appears to afford effective protection against shaped charges are to be tested with HEP and AP projectiles.